Research and Practice of Intensive Use of Land based on the Fuzzy Evaluation

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Abstract

On the basis of the theoretical analysis, this paper adopted the method that quantitative analysis combines with qualitative analysis, established corresponding evaluation index system, and the weights were determined using AHP. The fuzzy evaluation method were carried out to overall and stratified fuzzy evaluation in a development zones, based on the evaluation criteria the overall level of intensive use of land was obtained, and three hierarchical land-use intensity was obtained in Land-use intensity, land-use number structure, land-use spatial structure.

Keywords: fuzzy evaluation, intensive use of land.

Introduction.

The current process of urbanization in China into the period of accelerated development, urban development, the rapid expansion of construction land. Therefore, in terms of protection of land resources, urban development and the perspective of the rational allocation of urban land, or from the best of economic growth point of view, the topic of Urban land intensive use are very important[1]. Urban land intensive use is to optimize land use structure and the premise of sustainable development, by utilizing land in stock, improve management, land use fully the potential of other channels, so that construction of urban land use efficiency is improved, and made good economic, social and ecological benefits of the process[2]. At present in the intensive utilization of land evaluation to quantitative analysis of process methods and models, mainly including maximum conditions, multi-factor comprehensive evaluation method, Cluster Analysis, Regression Analysis, AHP, Fuzzy Evaluating Method, Entropy Method, Synergisticity Model and so on. Their applications make evaluation system for the intensive utilization of land to be perfect gradually. Literature [3-4] studied General intensive land use fuzzy evaluation from the macro-level. Taking example for Development Area, uses fuzzy evaluation model studies Land Use Intensity from both aspects of overall and stratified.
1. The Establishment of the Development Area Evaluation Indicator System and the Determination of the Weight

1.1. Evaluation Indicator System

Urban land use is a multi-level, multi-target system, whether the intensive use of urban land reflects the economic system, resource system, environmental system, social system, and many other benefits of the balance. To the performance of such multi-dimensional vector, we must apply a set of index system. According to the principle of index system, combined with the status of Development Area to establish The Index System, as shown in table 1:

1.2. The Determination of the Weight

According to the content of index system, Determination of Weight Value by AHP. Analytic hierarchy process (AHP) put complicated problem decomposition for each component factors, according to these factors dominating relations group formed orderly by class times structure. By way of comparison between two levels in determining the IRI of various factors, and then integrated human judgments to determine the relative importance of various factors. (Table.1)

<table>
<thead>
<tr>
<th>Evaluation content</th>
<th>Stratification weights</th>
<th>Evaluating Indicator</th>
<th>Stratification weights</th>
<th>Final Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utilization Strength A1</td>
<td>0.6071</td>
<td>FAR of industrial land B1</td>
<td>0.1144</td>
<td>0.069452</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FAR of residential land B2</td>
<td>0.0765</td>
<td>0.046443</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Construction density B3</td>
<td>0.171</td>
<td>0.103814</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Integration FAR B4</td>
<td>0.2557</td>
<td>0.155235</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Comparison FAR B5</td>
<td>0.3824</td>
<td>0.232155</td>
</tr>
<tr>
<td>the quantity structure of land-use A2</td>
<td>0.2715</td>
<td>The proportion of development zone residential land C1</td>
<td>0.3875</td>
<td>0.105206</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The proportion of development zone industrial land C2</td>
<td>0.3875</td>
<td>0.105206</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Development zone greenage Rate C3</td>
<td>0.0775</td>
<td>0.021041</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Development zone infrastructure land rate C4</td>
<td>0.1475</td>
<td>0.040046</td>
</tr>
<tr>
<td>space structure of land-use A3</td>
<td>0.1214</td>
<td>Industrial output per unit of land D1</td>
<td>0.2715</td>
<td>0.03296</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Output per unit of land area D2</td>
<td>0.6071</td>
<td>0.073702</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Comparison of unit of industrial land D3</td>
<td>0.1214</td>
<td>0.014738</td>
</tr>
</tbody>
</table>

2. The generation of the evaluation set

Based on the current analysis and comparison of different evaluation standard. According to the conditions and characters of urban land use, In the grade standards on evaluation choice at land intensive use of Development Zone, we adopted a 4th level evaluation standard. The generation of the evaluation
set marked as: \( V = \{ v_1, v_2, v_3, v_4 \} \), \( V_1, \ldots, V_4 \) is the Potential categories of land, mean \( V_1 \) as Low use, \( V_2 \) as proper use, \( V_3 \) as Intensive use, \( V_4 \) as Over use.

3. Membership determination

3.1 Standard form of Evaluation factors

Determine the standard value of each factor is a very complex process, according to (TD/T 1014-2007)、（GBJ137-90）、the shandong province and its actual situation of zone, and some other material, identify the standard form of Evaluation factors(Table.2)

<table>
<thead>
<tr>
<th>Standard Values evaluation indicator</th>
<th>'1'</th>
<th>'2'</th>
<th>'3'</th>
<th>'4'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low use</td>
<td>&lt;0.25</td>
<td>0.25-0.37</td>
<td>0.37-0.56</td>
<td>0.56-0.9</td>
</tr>
<tr>
<td>FAR of industrial land</td>
<td>&lt;0.4</td>
<td>0.4-0.75</td>
<td>0.75-1.13</td>
<td>1.13-1.5</td>
</tr>
<tr>
<td>FAR of residential land</td>
<td>&lt;0.1</td>
<td>0.1-0.25</td>
<td>0.25-0.35</td>
<td>0.35-0.5</td>
</tr>
<tr>
<td>Construction density</td>
<td>&lt;0.38</td>
<td>0.38-0.7</td>
<td>0.7-1.02</td>
<td>1.02-1.3</td>
</tr>
<tr>
<td>Integration FAR</td>
<td>&lt;0.4</td>
<td>0.4-0.8</td>
<td>0.8-1.2</td>
<td>1.2-2.0</td>
</tr>
<tr>
<td>Comparison FAR</td>
<td>&lt;0.4</td>
<td>0.4-0.8</td>
<td>0.8-1.2</td>
<td>1.2-2.0</td>
</tr>
<tr>
<td>The proportion of development zone residential land</td>
<td>&lt;0.1</td>
<td>0.1-0.15</td>
<td>0.15-0.2</td>
<td>0.2-0.5</td>
</tr>
<tr>
<td>The proportion of development zone industrial land</td>
<td>&lt;0.15</td>
<td>0.15-0.25</td>
<td>0.25-0.35</td>
<td>0.35-0.5</td>
</tr>
<tr>
<td>Development zone greengage Rate</td>
<td>&lt;0.15</td>
<td>0.15-0.3</td>
<td>0.3-0.4</td>
<td>0.4-0.5</td>
</tr>
<tr>
<td>Development zone infrastructure land rate</td>
<td>&lt;0.1</td>
<td>0.1-0.16</td>
<td>0.16-0.29</td>
<td>0.29-0.5</td>
</tr>
<tr>
<td>Industrial output per unit of land</td>
<td>&lt;250</td>
<td>25000-35000</td>
<td>35000-50000</td>
<td>50000-65000</td>
</tr>
<tr>
<td>Output per unit of land area</td>
<td>&lt;130</td>
<td>13000-27000</td>
<td>27000-34000</td>
<td>34000-50000</td>
</tr>
<tr>
<td>Comparison of unit of industrial land</td>
<td>&lt;0.5</td>
<td>0.5-0.8</td>
<td>0.8-1.2</td>
<td>1.2-2</td>
</tr>
</tbody>
</table>

3.2 Membership determination

Based on the standard form of Evaluation factors, used of lower half of the membership function of trapezoidal fuzzy distribution model to calculate the membership. Taking the membership Fuction of the FAR of industrial land for Example Low use
Accordingly, based on the lower half of the membership function of trapezoidal fuzzy distribution model, we can create the membership function of \( u_2 \) FAR of residential land, \( u_3 \) Construction density, \( u_4 \) Integration FAR, \( u_5 \) Comparison FAR, \( u_6 \) The proportion of development zone residential land, \( u_7 \) The proportion of development zone industrial land, \( u_8 \) Development zone greenage Rate, \( u_9 \) Development zone infrastructure land rate, \( u_{10} \) Industrial output per unit of land, \( u_{11} \) Output per unit of land area, \( u_{12} \) Comparison of unit of industrial land, after computing can get below judgment matrix.

\[
R = \begin{bmatrix}
0.083 & 0.917 & 0.000 & 0.000 \\
0.000 & 0.132 & 0.868 & 0.000 \\
0.500 & 0.500 & 0.000 & 0.000 \\
0.781 & 0.219 & 0.000 & 0.000 \\
0.000 & 0.825 & 0.175 & 0.000 \\
0.000 & 0.780 & 0.220 & 0.000 \\
0.000 & 0.000 & 0.733 & 0.267 \\
0.713 & 0.287 & 0.000 & 0.000 \\
0.000 & 0.262 & 0.738 & 0.000 \\
0.500 & 0.500 & 0.000 & 0.000 \\
0.286 & 0.714 & 0.000 & 0.000 \\
0.000 & 0.550 & 0.450 & 0.000 \\
\end{bmatrix}
\]

(5)

4. For fuzzy change requesting assessment results

Vector B of evaluation results will be acquired by conducting Compositional Operation to the evaluation matrixes based on the calculated weight assignment and judgment matrixes. Working formulas:

\[
B = A \ast R
\]

(6)

A is weighted vector, fuzzy transform operator and outstanding factor taking general operator. The corresponding element of namely A and R multiply then add, getting B. B is the comprehensive evaluation result based on the evaluation factors of U. According to fuzzy mathematics maximum subjection principle, synthetic operation’s result is a group of grade membership value, taking membership of
the corresponding level attributes as the level of evaluation units function. In order to make full use of level fuzzy subsets of B brought about the information, we make full consideration of kinds parameters and evaluation result B, making the results practically. The various ranks of parameters column vector:

\[ V = (V_1, V_2, V_3, V_4)^T \]  

(7)

The comprehensive evaluation results for the final grades parameters is obtained.

\[ B \times V = (B_1, B_2, B_3, B_4) \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{bmatrix} = P \]  

(8)

P can be considered to level fuzzy subsets of B for weight vectors about level parameters of average weight. P reflects the comprehensive information level fuzzy subsets of B and level of vector parameter V bring.

According to the weight calculation, we can conclude:

\[ A = \begin{bmatrix} 0.06945 & 0.04644 & 0.10381 & 0.15523 & 0.23215 & 0.10520 \\ 0.10520 & 0.02104 & 0.04004 & 0.0329 & 0.07370 & 0.01473 \end{bmatrix} \]

Through calculation, we can conclude:

\[ B = [0.232, 0.523, 0.211, 0.028] \]  

(9)

After comprehensive consideration of the rating, we can get the final result.

\[ V = [0.25, 0.35, 0.45, 0.55] \]  

P = B × V = 0.3514

According to the results of combined operations, in accordance with the principle of maximum membership degree, Zibo Development Zone, the final level of intensive land use reviews for the 0.523 level, corresponding the evaluation set to that proper use, and its membership is 0.3514, the level of intensive use in the second grade and third grade (proper use and the intensive use) between and below the second level and third level of the median score (0.4), indicating that the level of Land Intensive Use in Development Zones for the moderate bias.

5 Hierarchical Fuzzy Evaluation of Development

Hierarchical fuzzy evaluation criteria for the three layer fuzzy evaluation, it has the principle of comprehensive fuzzy evaluation.

5.1 Zone-based assessment of land use intensity level

Land Use intensity factors of Development Zones: FAR of industrial land, FAR of residential land, Construction density, Integration FAR, Comparison FAR.

According to the principle of fuzzy evaluation for that judgment matrix:
Vector of evaluation results will be acquired by conducting Compositional Operation to the evaluation matrixes based on the calculated weight assignment and judgment matrixes.

\[ b = a \cdot r = \begin{bmatrix} 0.295 & 0.572 & 0.133 & 0.000 \end{bmatrix} \]  \hspace{1cm} (14)

Land utilization potential of Development Zone in the arrangement of space structure of land-use is intensive use from the principle of maximum membership degree.

5.2 Zone-based assessment of the quantity structure of land-use

The proportion of development zone residential land, The proportion of development zone industrial land, Development zone greenage Rate, Development zone infrastructure land rate. According to the principle of fuzzy evaluation for that judgment matrix:

\[ r = \begin{bmatrix} 0.083 & 0.917 & 0.000 & 0.000 \\ 0.000 & 0.132 & 0.868 & 0.000 \\ 0.500 & 0.500 & 0.000 & 0.000 \\ 0.781 & 0.219 & 0.000 & 0.000 \\ 0.000 & 0.825 & 0.175 & 0.000 \end{bmatrix} \]  \hspace{1cm} (12)

Stratification weights:

\[ a = \begin{bmatrix} 0.1144 & 0.0765 & 0.171 & 0.2557 & 0.3824 \end{bmatrix} \]  \hspace{1cm} (13)

Vector of evaluation results will be acquired by conducting Compositional Operation to the evaluation matrixes based on the calculated weight assignment and judgment matrixes.

\[ b = a \cdot r = \begin{bmatrix} 0.295 & 0.572 & 0.133 & 0.000 \end{bmatrix} \]  \hspace{1cm} (14)

Land utilization potential of Development Zone in the arrangement of space structure of land-use is intensive use from the principle of maximum membership degree.

5.3 Zone-based assessment of space structure of land-use

space structure of land-use factors of Development Zones: Industrial output per unit of land, Output per unit of land area, Comparison of unit of industrial land. According to the principle of fuzzy evaluation for that judgment matrix:

\[ r = \begin{bmatrix} 0.500 & 0.500 & 0.000 & 0.000 \\ 0.500 & 0.500 & 0.000 & 0.000 \\ 0.000 & 0.550 & 0.450 & 0.000 \end{bmatrix} \]  \hspace{1cm} (18)

Stratification weights:
Vector of evaluation results will be acquired by conducting Compositional Operation to the evaluation matrixes based on the calculated weight assignment and judgment matrixes.

\[ a = \begin{bmatrix} 0.2715 & 0.6071 & 0.1214 \end{bmatrix} \] \hspace{1cm} (19)

\[ b = a \cdot r = \begin{bmatrix} 0.309 & 0.636 & 0.055 & 0.000 \end{bmatrix} \] \hspace{1cm} (20)

Land utilization potential of Development Zone in the arrangement of space structure of land-use is intensive use from the principle of maximum membership degree.

6 Conclusion

Based on the evaluation results can be seen, the level of land intensive use potential in development zones for the moderate bias. From hierarchical evaluation results can be seen in land use intensity and space structure of land-use for the proper use, only the quantity structure of land-use for intensive use. This can be seen that restrict intensive land use of development zone main factors were development zone land use intensity and space structure of land-use.

References


